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The Chemical Evolution of Milky Way Satellite Galaxies from Keck/DEIMOS Multi-Element Abundance Measurements

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Abstract. A Keck/DEIMOS spectroscopic campaign of eight Milky Way (MW) dwarf spheroidal (dSph) satellite galaxies has generated spectral synthesis-based abundance measurements for nearly 3000 stars. The elements measured are Fe and the α elements Mg, Si, Ca, and Ti. The dSph metallicity distributions show that the histories of the less luminous dSphs were marked by massive amounts of gas loss. The [α/Fe] distributions indicate that the early star formation histories of most dSphs were very similar and that Type Ia supernova ejecta contributed to the abundances of all but the most metal-poor ([Fe/H] < -2.5) stars.

1. The Keck/DEIMOS Spectroscopic Sample

We obtained Keck/DEIMOS spectra of about 3000 red giants in eight MW dSphs. From these spectra, we measured Mg, Si, Ca, Ti, and Fe abundances from neutral absorption lines. The resulting catalog was published by Kirby et al. (2010).

2. Metal Loss from Dwarf Galaxies

The mass of metals a galaxy produces ($M_{\rm produced}$) may be estimated from its stellar mass, an assumed initial mass function, and theoretical supernova yields. Our Keck/DEIMOS campaign has targeted eight MW dSphs, and the resulting spectra have allowed us to measure the detailed metallicity distribution for each galaxy. The integral of the metallicity distribution is the mass of metals remaining in the galaxy ($M_{\rm retained}$). The difference between $M_{\rm produced}$ and $M_{\rm retained}$ is the amount of metals lost. It turns out that smaller galaxies lose a larger fraction of their metals. Fornax lost 96% of the iron it produced, and Ursa Minor lost 99.8%, as shown in Figure 1. Please refer to Kirby et al. (2011b) for more details.

3. Star Formation Histories of Dwarf Galaxies

Figure 2 shows how different α elements change with [Fe/H] in the dSphs. At [Fe/H] $<$ -1.2, the [α/Fe] ratios follow nearly the same path in all dSphs, suggesting similar star formation histories at early times. Furthermore, with few exceptions, there are no [α/Fe] plateaus at [Fe/H] > -2.5, which indicates that Type Ia supernova ejecta contributed to all but the most metal-poor stars. Please refer to Kirby et al. (2011a) for more details.

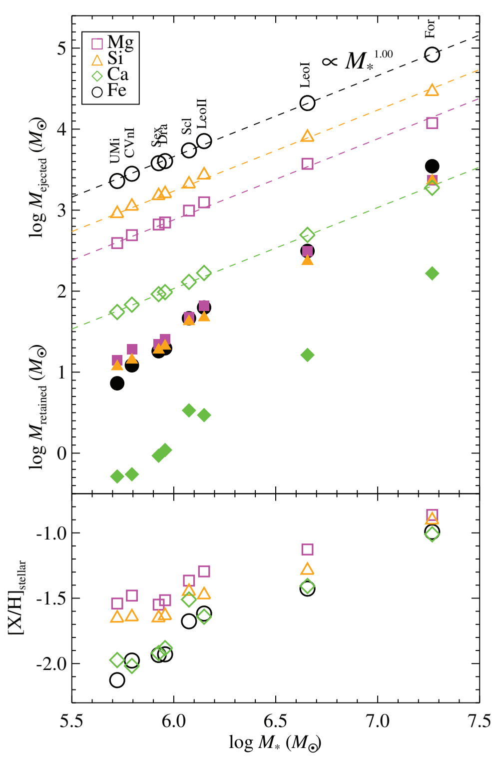

Figure 1. (color online) For each of the eight MW dSphs we observed with DEIMOS, $M_{\rm retained}$ is shown as a filled point in the top panel. The colors and shapes of the points denote the element measured. The difference between $M_{\rm produced}$ and $M_{\rm retained}$ is the amount of metals lost (hollow points). The bottom panel shows the mass-metallicity relation.

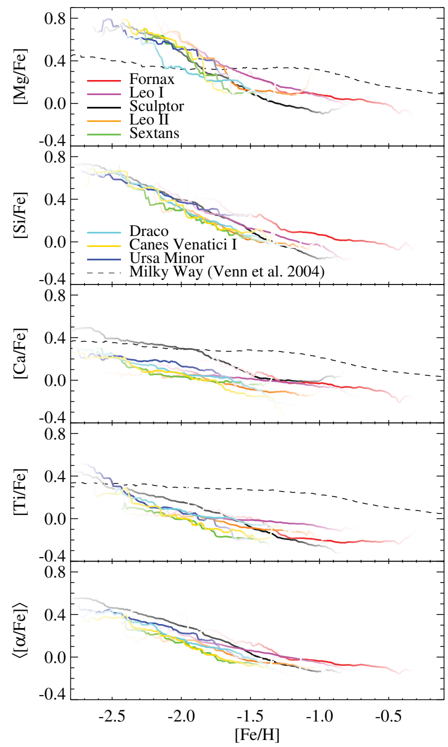

Figure 2. (color online) Moving averages of the [α/Fe] ratios in MW dSphs. The figure legend lists the dSphs in order of decreasing luminosity.

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